Implementation of SLIM KILAB as a Transformation of the Information Service System Designed to Manage High School Laboratories

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ABSTRACT

This study investigates the use of the Systematic Laboratory Innovation Management for Chemistry Laboratories (SLIM KILAB) model as a strategic framework or enhancing laboratory management practices in Indonesian high schools. The study was conducted in two public senior high schools in Lampung Province using a qualitative descriptive design that included semi-structured interviews, participatory observations, and document analysis. The participants included two laboratory coordinators and two chemistry teachers in charge of laboratory operations. The findings show that the SLIM KILAB model increased administrative efficiency, improved safety compliance, and optimized tool and material use. The model's digital system also improved practicum scheduling, monitoring, and reporting, resulting in a more organized and transparent laboratory environment. Despite these benefits, challenges such as limited infrastructure and teacher preparedness remain. The study concludes that SLIM KILAB is a promising innovation for modernizing school laboratories, particularly in resource-constrained settings, and recommends further expansion supported by targeted training and infrastructure development.

Keywords
SLIM KILAB; Laboratory management; Digital innovation, Secondary education, Chemistry education

Introduction

The laboratory is an important setting for experiential science learning, particularly in chemistry education, because it reinforces conceptual understanding through hands-on experiments. However, in Indonesian secondary schools, the effectiveness of chemistry laboratories is frequently hampered by a lack of financial and material resources, outdated operational procedures, and minimal innovation in laboratory management. These challenges prevent laboratories from being dynamic spaces for inquiry-based learning and scientific discovery.

Although numerous efforts have been made to improve the infrastructure and resources of school laboratories, managerial practices in this area remain relatively stable. Sustainable transformation in laboratory management necessitates not only the acquisition of modern equipment but also a complete overhaul of how laboratories are organized, used, and maintained. Recognizing this gap, SLIM KILAB (Systematic Laboratory Innovation Management for Chemistry Laboratories) was created as a structured, adaptable, and innovation-focused model for chemistry laboratory management.

The purpose of this study is to investigate the use of the SLIM KILAB model in several high schools in Lampung Province, Indonesia. It aims to determine how this model can drive institutional change in laboratory governance, improve chemical pedagogy, and instill a safety culture as a core component of the laboratory. This approach is expected to make a significant contribution to science education policy and practice, especially in resource-constrained schools. The SLIM KILAB system was developed in response to the increasing integration of digital technology in education, and it supports the transformation of laboratory management toward more modern, efficient, and student-centered practices.

To contextualize this model, it is important to first understand the theoretical foundations and previous studies related to laboratory management and digital transformation, which are discussed in the next section.

Literature Review

In science education, laboratories play an essential role as spaces for experiential learning and scientific exploration. However, many chemistry laboratories in Indonesian secondary schools remain underutilized due to outdated management practices, manual record-keeping, and limited access to technology. Previous research has addressed these challenges and proposed various digital and integrated management models to improve laboratory governance.

The table below summarizes relevant studies that support the need for a digital, structured, and systematic approach to laboratory management:

Table 1. Previous Studies on Laboratory Management and Digital Systems

No	Topic	Subtopic	Key Findings	Source
1	Role of Chemistry Laboratory	Laboratory as inquiry-based learning environment	Chemistry labs help students explore abstract concepts and support conceptual understanding through hands-on practice.	Pangestu & Sukardi (2019)
2	Laboratory Management Problems	Manual systems, lack of SOP	Many schools do not use digital systems, resulting in inefficiency, undocumented procedures, and higher safety risks.	Mohzana et al. (2023)
3	Need for Management Model	Structured laboratory governance	A systematic and standardized model is required to improve school laboratory performance and compliance.	Pangestu & Sukardi (2019)
4	Digital Innovation in Labs	Inventory and reporting systems	Digital platforms enhance administrative efficiency and allow real-time tracking of inventory and schedules.	Zhai (2024); Jian et al. (2023)
5	Smart Laboratory Systems	QR codes, mobile access, automation	Smart labs increase transparency and reduce manual errors by integrating mobile systems and automatic monitoring tools.	Bardoe et al. (n.d.); Kang & Park (2020)
6	SLIM KILAB Model	Web-based laboratory management	SLIM KILAB integrates inventory tracking, scheduling, SOP documentation, and borrowing systems in one digital platform.	Fauzi et al. (2024); Purnomo et al. (2022)
7	Implementation Effectiveness	Accountability and efficiency	Digital systems reduce teacher workload and strengthen administrative transparency and safety practices in school laboratories.	Adekunle et al. (2024); Bao & Toyeng (2024)
8	Implementation	Infrastructure and	Despite the benefits, limited	Hung & Shaid

	Challenges	human resources	infrastructure and teacher readiness are key barriers to system adoption in low-resource schools.	(2025)

Topic

The digitization of laboratory management has become a major focus in modern education systems. This transformation enables schools to integrate laboratory inventories, scheduling, safety protocols, and student access into a unified digital framework. Prior studies confirm that digital management tools not only optimize laboratory use but also foster a culture of accountability and safety.

Subtopic

One of the emerging models in this area is SLIM KILAB (Systematic Laboratory Innovation Management), a web-based application tailored for secondary school chemistry laboratories. The model includes real-time inventory control, practicum scheduling, borrowing records, and auto-generated SOP access. Research supports that such systems are effective in environments with limited resources, as long as appropriate training and technical support are provided.

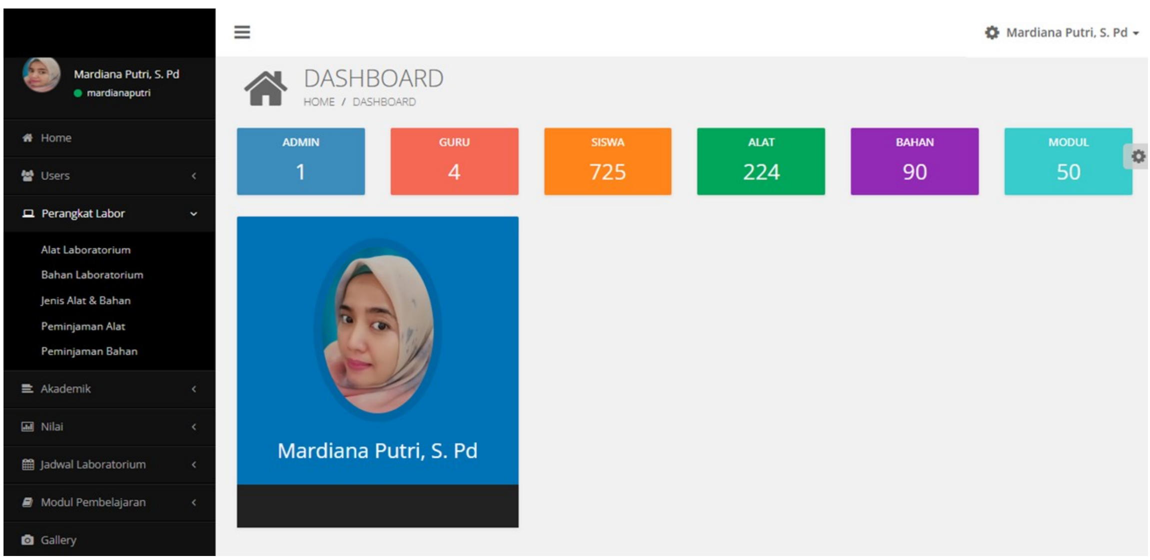

Figure 1. Example of SLIM KILAB Interface

In summary, the literature suggests that digital transformation in laboratory management is necessary to bridge gaps in quality and access, especially in science education. This study builds upon those findings by implementing and evaluating SLIM KILAB in the context of Indonesian high schools.

Methods

This study employed a qualitative approach to investigate the implementation and effectiveness of the SLIM KILAB model as an innovation in chemistry laboratory management in senior high schools. The research focused on understanding the experiences of teachers and laboratory personnel in utilizing the system, including its benefits, challenges, and practicality in real school settings. The primary research site was SMA Negeri 7 Bandar Lampung, where the model was implemented in full. To enrich the data and provide cross-validation, Focus Group Discussions (FGDs) were also conducted at SMA Negeri 14 Bandar Lampung and SMA Negeri 16 Bandar Lampung. This section presents the research design, participants, instruments, and data analysis techniques.

Research Design

The study utilized a qualitative descriptive design, appropriate for exploring the implementation of educational innovations in natural settings. This design allows for a rich description of the processes, behaviors, and perspectives of the participants. As described by Creswell and Poth (2018), qualitative description is suitable for analyzing complex social phenomena in context. The research aimed to capture the real-life dynamics of chemistry laboratory management before and after the adoption of the SLIM KILAB model, emphasizing observable practices and user experiences.

Samples and Population / Participants

The research involved three senior high schools in Bandar Lampung, Indonesia. The main implementation site was SMA Negeri 7 Bandar Lampung, selected for its readiness to apply the SLIM KILAB model. Complementary data were gathered through Focus Group Discussions (FGDs) at SMA Negeri 14 Bandar Lampung and SMA Negeri 16 Lampung to compare perspectives and enrich the findings. Their insights were vital to understanding the practical application and institutional support surrounding SLIM KILAB.

Research Instruments

Three main instruments were used to collect data:

1. Observation Sheets – to document the conditions and practices of laboratory management before and after SLIM KILAB implementation, including equipment organization, user interaction, and compliance with SOPs.
2. Semi-Structured Interview Guides – to explore participants' perceptions, challenges, and perceived improvements due to the new system.
3. Document Analysis Checklists – to review laboratory records, inventories, user logs, SOPs, and printed reports from the SLIM KILAB application.

These instruments were designed to ensure triangulation and comprehensiveness in understanding both procedural and experiential aspects of the system's use.

Data Analysis

Thematic analysis was employed to process and interpret the qualitative data collected. The process involved open coding of the transcripts and field notes, followed by categorizing and clustering data into meaningful themes. This approach, guided by Braun and Clarke (2006), enabled the identification of recurring patterns related to user engagement, system efficiency, and managerial outcomes. Triangulation was applied across data sources (interviews, observations, documents), and member checking was used to ensure credibility, where participants reviewed summaries of the findings for validation.

Results

The implementation of the SLIM KILAB model across two public senior high schools in Lampung Province resulted in substantial transformations in laboratory governance, safety compliance, and instructional support. The data collected from semi-structured interviews, participatory observations, and document analysis provide a multi-dimensional understanding of the system's impact.

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1. Stakeholders' Perspectives on Laboratory Challenges and Changes (Interview Data)

Prior to the implementation of the SLIM KILAB model, interviews with key stakeholders—including laboratory coordinators and chemistry teachers—revealed recurring issues that impeded effective laboratory management. These included fragmented inventory systems, absence of integrated digital administrative tools, and inconsistent application of safety protocols. Such conditions often resulted in resource mismanagement, poor coordination, and heightened risks during practicum activities.

Following the deployment of SLIM KILAB, participants described substantial improvements in daily operations:

a) Inventory management became more efficient and transparent through a real-time digital system, significantly reducing the loss and misplacement of laboratory equipment and chemicals.
b) Collaboration between teachers and laboratory coordinators improved due to structured, centralized access to data and schedules.
c) Safety practices were more consistently implemented, supported by standardized digital Standard Operating Procedures (SOPs) and system-generated reminders accessible via mobile or desktop devices.

One participating teacher noted: *"SLIM KILAB membuat semua data alat dan bahan lebih rapi dan mudah dicek, bahkan kami bisa langsung tahu kapan alat terakhir dipakai."* (*"SLIM KILAB made all equipment and materials data more organized and easier to check; we can even see when an item was last used."*)

These insights align with existing studies emphasizing the positive impacts of digital integration in laboratory environments, particularly in fostering transparency, accountability, and operational efficiency (Tüysüz, 2010; Kang & Park, 2020). Digital systems enable better traceability and more responsive management, contributing to a more robust laboratory culture in educational settings.

2. Real-Time Laboratory Practices and Safety Protocols (Observational Data)

Participatory observations conducted across multiple practicum sessions in the three selected schools confirmed the improvements reported in stakeholder interviews. These direct observations provided evidence of enhanced laboratory operations and adherence to safety protocols following the implementation of the SLIM KILAB model.

Key findings include:

a) Consistent enforcement of safety measures was evident, with all students and staff wearing appropriate personal protective equipment (PPE) such as lab coats and goggles. Chemical substances were clearly labeled, and safety signage was prominently displayed in each laboratory.
b) Shared responsibilities were well-coordinated; teachers and laboratory staff collaboratively prepared experimental setups, ensured readiness of materials, and supervised students throughout the practical activities.
c) Digital access to SOPs and inventory data via tablets or printed QR codes strategically placed near storage areas significantly improved material handling processes and hazard identification. These technologies enabled real-time reference to procedural guidelines and stock status, enhancing both efficiency and compliance.

These observed practices underscore the importance of integrating structured digital systems to reinforce safety culture and streamline operational procedures in school laboratories. The findings echo earlier research by Hofstein and Lunetta (2004), which emphasized that consistent safety practices and active teacher involvement are critical for effective science learning environments. The use of digital tools in SLIM KILAB enhances these elements by embedding safety and structure into daily lab operations.

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3. Managerial Shifts in Laboratory Governance (Document Analysis)

The analysis of institutional documents before and after the implementation of the SLIM KILAB model revealed substantial shifts in laboratory governance and managerial practices. These changes reflect a transition toward more structured, transparent, and data-driven management systems.

The key improvements identified include:

a) Digitization of inventory management**:** Traditional manual logbooks were replaced by a centralized digital inventory system that provides real-time data on the availability, condition, and usage history of laboratory equipment and chemicals.
b) Standardization of operational procedures**:** Laboratory Standard Operating Procedures (SOPs) were revised and formalized to align with institutional policies, ensuring consistency and legal compliance across practical activities.
c) Automated reporting systems: The SLIM KILAB model introduced automated usage reports that assist in planning resource needs, tracking consumption patterns, and enhancing overall accountability in laboratory operations.

These managerial developments are consistent with Bowen's (2009) argument that document analysis is instrumental in tracing systemic changes and evaluating the institutionalization of new practices. The transformation observed through SLIM KILAB underscores how digital governance can facilitate more sustainable and accountable laboratory administration, particularly in educational settings where resource optimization and procedural transparency are essential.

4. Core Functions of the SLIM KILAB Model

Based on empirical data from interviews, observations, and document analysis, the SLIM KILAB model functions as a comprehensive digital framework designed to optimize chemistry laboratory management in secondary education. The model is centered on three core operational components:

a) Inventory Management

SLIM KILAB features a real-time digital inventory system that logs the availability, usage history, and condition of laboratory tools and chemicals. This minimizes redundancy and human error, allowing laboratory coordinators to monitor resource flow with greater accuracy and efficiency. Such real-time tracking enhances transparency and ensures that materials are appropriately maintained and replenished (Zhu & Zayim, 2021).

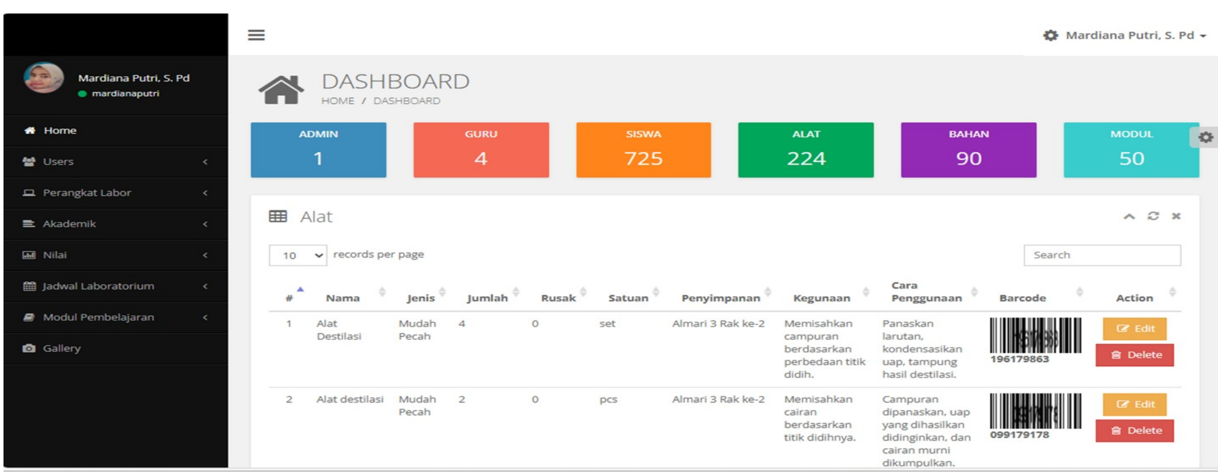

Figure 2. *Laboratory Equipment Inventory Feature in SLIM KILAB.*

b) Practicum Administration

The system facilitates the administrative management of practicum activities, including scheduling, student attendance, and performance assessment. Teachers and laboratory staff can access and update data efficiently, which fosters collaboration and accountability in instructional delivery. By centralizing these processes, Management Laboratories reduces paperwork and supports pedagogical alignment with digital transformation efforts in education (Yuliati et al., 2022).

c) Usage Reporting

SLIM KILAB automatically generates reports on the utilization of equipment and materials. These reports assist school administrators and laboratory personnel in planning budgets, managing procurement, and identifying usage trends. In doing so, the model contributes to more strategic and sustainable decision-making in laboratory resource allocation and operational planning (Zhu & Zayim, 2021).

The integration of these functions reflects global trends in digital laboratory management, which emphasize efficiency, safety, and data-informed governance in educational contexts. As schools increasingly adopt digital solutions, models like SLIM KILAB offer scalable and contextually adaptable approaches to modernize laboratory practices while supporting instructional goals.

Discussions

The findings of this study highlight the transformative role of the SLIM KILAB model in improving the governance of high school chemistry laboratories. The model's implementation led to tangible improvements in inventory tracking, practicum administration, and safety compliance. These enhancements affirm the critical need for digital-based laboratory management in education, especially amid growing demands for transparency, efficiency, and pedagogical support in STEM learning environments (Wieman & Gilbert, 2014; Zhu & Zayim, 2021).

One of the major benefits observed was the transition from manual to digital inventory systems. The SLIM KILAB platform enabled schools to maintain up-to-date and accurate records of tools and chemicals, minimizing material loss and improving inventory accessibility. This transition from paper-based logs to a centralized digital system streamlined inventory management, ensuring that all items were accurately tracked and easily accessible for use. This shift not only reduced human error but also improved the efficiency of laboratory operations.

The enhanced inventory management features of SLIM KILAB facilitated more effective resource planning, as lab coordinators and teachers could quickly access real-time data on the availability and condition of materials. This improvement is consistent with Kang and Park (2020), who emphasize that smart laboratory systems play a crucial role in streamlining logistics and reducing the cognitive load on educators and laboratory staff. The system's ability to minimize material loss by providing immediate notifications and updates on inventory levels supports better decision-making and operational efficiency.

Moreover, the digital documentation provided by SLIM KILAB also enables real-time monitoring, a critical component in ensuring that laboratory resources are used sustainably. Real-time tracking of inventory data allows lab managers to predict material usage, plan for replenishment, and avoid shortages or overstocking. Zayim and Ozel (2017) highlight the importance of such digital systems in maintaining the sustainability of laboratory operations, as they facilitate continuous oversight and more informed resource management decisions. By reducing waste and ensuring the optimal use of materials, the digital inventory system contributes to the long-term efficiency and cost-effectiveness of laboratory management.

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2. Efficient Practicum Administration

SLIM KILAB's ability to manage practicum schedules, attendance, and assessments significantly improved administrative efficiency in the laboratory. By centralizing these tasks, the platform reduced the administrative burden on teachers, enabling them to focus more on instructional quality and student engagement. Digital tools for managing practicum activities ensured smoother operations, including more effective planning and coordination between teachers and lab coordinators.

The system's streamlined approach to scheduling allowed for more accurate tracking of practicum sessions, ensuring that all activities were properly organized and aligned with the curriculum. Additionally, automated attendance and assessment features provided teachers with quick access to important student data, thus improving the management of student progress and performance. As a result, teachers could devote more time to interactive teaching and less to administrative tasks, making the overall practicum experience more productive.

Furthermore, the ease with which teachers could access historical practicum data encouraged reflective practice. Teachers were able to review past sessions to identify areas for improvement, make necessary adjustments, and plan more effectively for future practicum activities. This continuous cycle of reflection and improvement aligns with the findings of Yuliati, Handhika, and Susantini (2022), who argue that digital systems enhance instructional planning by providing easy access to historical data, which fosters reflective practices and better decision-making.

The broader literature also supports these findings. Selwyn (2016) emphasizes the role of integrated digital platforms in simplifying administrative workflows within schools, ultimately leading to more effective use of time and resources. The efficiency gained through SLIM KILAB's digital administration not only benefited teachers but also contributed to a more organized and consistent delivery of practicum activities, supporting both pedagogical effectiveness and administrative coherence.

3. Improved Safety Compliance and SOP Standardization

The implementation of SLIM KILAB significantly enhanced safety compliance in the laboratory by integrating standardized operating procedures (SOPs) into the digital system. The platform's use of QR codes posted in laboratories allowed students and teachers easy access to the necessary safety guidelines and protocols directly from their mobile devices or tablets. This innovation ensured that SOPs were always readily available, making it easier for students and staff to adhere to safety measures during experiments.

The digital accessibility of SOPs improved the consistency and enforcement of safety protocols across the laboratories. Teachers and lab managers could ensure that safety measures were uniformly followed, such as the mandatory use of lab coats, goggles, and gloves, and the proper labeling and storage of chemicals. This standardization contributed to a safer laboratory environment, where both students and staff were continuously reminded of best safety practices.

These findings align with the arguments presented by Hofstein and Lunetta (2004), who emphasized that structured and predictable laboratory environments are critical for fostering both student engagement and safety. The clear and consistent application of safety protocols not only protected participants from potential hazards but also cultivated a culture of safety, which is essential for responsible scientific inquiry. Furthermore, the integration of safety protocols into the digital system helped reinforce these behaviors, making safety a natural part of the laboratory routine rather than a separate, occasionally enforced, aspect of the experience.

The role of safety compliance in shaping students' attitudes toward responsible scientific inquiry is also emphasized by Ramnarain and Hobden (2015), who argue that a well-managed and safe laboratory environment is instrumental in developing students' attitudes toward science and research. When students consistently observe and engage with safety measures, they internalize these practices, leading to a deeper understanding of the importance of safety in scientific work.

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In summary, the integration of standardized SOPs through SLIM KILAB not only enhanced safety compliance but also fostered a responsible and safety-conscious laboratory culture. This improvement contributes significantly to both the immediate safety of students and teachers and the long-term development of students' attitudes toward scientific responsibility.

4. Stakeholder Engagement and Institutional Change

The findings from this study reveal that SLIM KILAB has not only driven technical improvements but also facilitated meaningful organizational change within the schools. The triangulated data, gathered through interviews, observations, and document analysis, consistently showed that stakeholders including teachers, lab coordinators, and administrative staff found SLIM KILAB to be a practical and relevant tool that met their needs. These positive responses indicate that the model has successfully aligned with the operational demands and educational goals of the schools involved.

The implementation of SLIM KILAB promoted enhanced role clarity, which is crucial for improving coordination and collaboration within the school. Before the model's implementation, roles and responsibilities regarding laboratory management and teaching practices were sometimes unclear or poorly defined. However, with the digital system in place, there was a clearer division of labor. Teachers were able to focus more on their teaching and pedagogical activities, while lab managers could handle the inventory, safety protocols, and resource management more effectively. This division of labor allowed for better collaboration between these two critical groups, ensuring that both teaching and laboratory operations ran smoothly and efficiently.

Moreover, SLIM KILAB's ability to centralize data and facilitate communication between teachers and lab managers improved the overall workflow and decision-making process. Teachers could easily access important information, such as inventory levels and SOPs, while lab managers had a clearer overview of the practicum schedules and material usage. This enhanced communication and cooperation between teachers and lab staff contributed to the overall success of the model in the schools.

These findings resonate with Lincoln and Guba's (1985) assertion that credible qualitative research must reflect the lived realities and value systems of the participants involved. By prioritizing the practical needs of stakeholders and ensuring that SLIM KILAB addressed these needs, the study highlights the significance of stakeholder engagement in fostering positive change. The model not only addressed immediate operational challenges but also encouraged an ongoing dialogue among stakeholders, leading to more collaborative, informed decision-making and a shift toward a more effective and efficient laboratory management system.

The successful implementation of SLIM KILAB in fostering role clarity and collaboration suggests that the model can serve as a tool for broader institutional change in school environments. This finding aligns with studies on organizational change in education, which emphasize the importance of clear roles, communication, and collaboration in achieving sustainable reforms (Fullan, 2007; Hargreaves, 2009). SLIM KILAB, therefore, represents a key step not only in modernizing laboratory management but also in driving systemic improvements within the institutional structures of schools.

Despite the successes reported in the implementation of the SLIM KILAB model, challenges remained that need to be addressed for further improvements. One particular challenge encountered by one of the participating schools was related to the limited digital infrastructure, which hindered the effective use of the system. In addition, some staff members had low levels of digital literacy, which delayed the full utilization of the SLIM KILAB platform. These challenges underscore a broader issue in the field of educational reform: the need for accompanying capacity-building efforts when introducing technological innovations.

As highlighted by Cuban (2001) and Patton (2015), the successful adoption of new technologies in educational settings requires more than just the provision of digital tools. It necessitates an aligned approach that includes substantial professional development, ongoing technical support, and the cultivation of a digital culture within schools. Teachers and administrative staff must not only be familiar with the tools but also understand how to integrate these tools into their existing pedagogical and administrative practices. Without this essential support and development, the full potential of digital systems like SLIM KILAB may remain unrealized.

Furthermore, the successful integration of SLIM KILAB depends on the readiness of the school to embrace such innovations. As Ertmer and Ottenbreit-Leftwich (2010) noted, successful technology integration is also deeply influenced by leadership commitment, institutional readiness, and the overall attitude towards technological change. School leadership plays a crucial role in ensuring that there is a shared vision for the use of digital tools, that teachers are adequately supported throughout the transition, and that the necessary resources are allocated to support the implementation.

Conclusion

The SLIM KILAB model has proven to be an effective laboratory management innovation in high school chemistry labs. By introducing digital inventory management, practicum administration, and automated reporting, the model improved efficiency, reduced material loss, and enhanced safety compliance. Interviews and observations showed improved coordination, safety practices, and accountability in laboratory operations. The integration of digital tools in lab management goes beyond technology; it transforms institutional routines and enhances STEM education. By centralizing tasks, SLIM KILAB reduced teacher workload and contributed to a more efficient lab environment. However, some challenges were faced, such as limited digital infrastructure and varying digital literacy among staff. These issues highlight the need for continuous professional development and institutional readiness. Despite these hurdles, the overall feedback from teachers and lab coordinators was highly positive, providing a strong foundation for exploring the model's broader applicability.

Furthermore, the system was intentionally designed to be scalable and adaptable for implementation across schools with diverse levels of infrastructure and resources. SLIM KILAB is not confined to its initial application at SMAN 7 Bandar Lampung—the pilot school—nor to the two trial schools, SMAN 14 Bandar Lampung and SMAN 16 Bandar Lampung. Its open and flexible framework allows other schools to adopt the system with minimal adjustments, including those in remote or resource-constrained areas. With these characteristics, SLIM KILAB holds strong potential to serve as a foundational model for the broader development of chemical laboratory management systems at the district or city level, and even at the national level.

Limitations and Future Studies

This study, while providing useful insights into the implementation of the SLIM KILAB model in high school chemistry laboratories, has some limitations. First, the study was only conducted in two public senior high schools in one province, which may limit the findings' applicability to other educational contexts with varying levels of infrastructure, teacher capacity, and administrative support. The purposive sampling strategy, while appropriate for qualitative research, inherently limits the diversity of perspectives, particularly from schools that have rejected or struggled with similar digital interventions.

Second, the study primarily examined the perspectives of laboratory coordinators and chemistry teachers. Other important stakeholders, such as students, school principals, and IT staff, were not involved in the data collection. In future research, it is recommended to actively involve students as participants to evaluate the impact of SLIM KILAB implementation on their learning engagement, independence, and readiness in laboratory-based learning. Their perspectives may provide additional insight into the broader institutional dynamics and user acceptance of the SLIM KILAB model. Third, while qualitative methods produced rich and contextualized data, the lack of a quantitative dimension makes it difficult to assess the effectiveness of SLIM KILAB in terms of numerical outcomes such as material waste reduction, efficiency gains, or student performance improvements. Furthermore, the study was conducted over a relatively short implementation period, which may have underestimated the model's long-term sustainability and institutionalization.

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Conflict of Interest

The authors declare no conflict of interest related to the research, authorship, or publication of this article.

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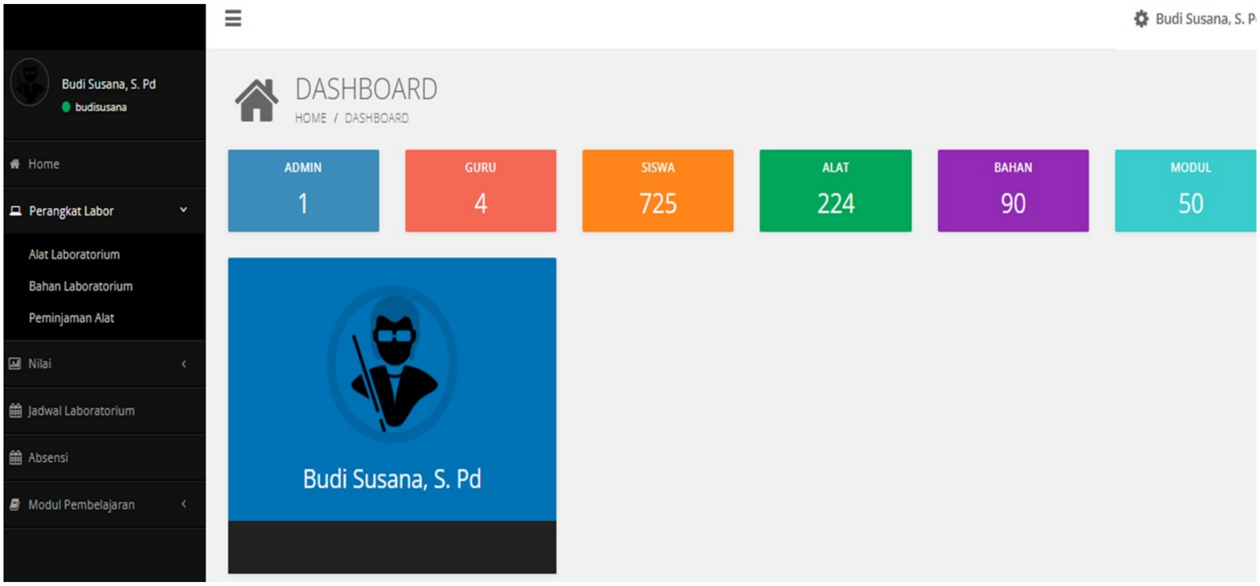
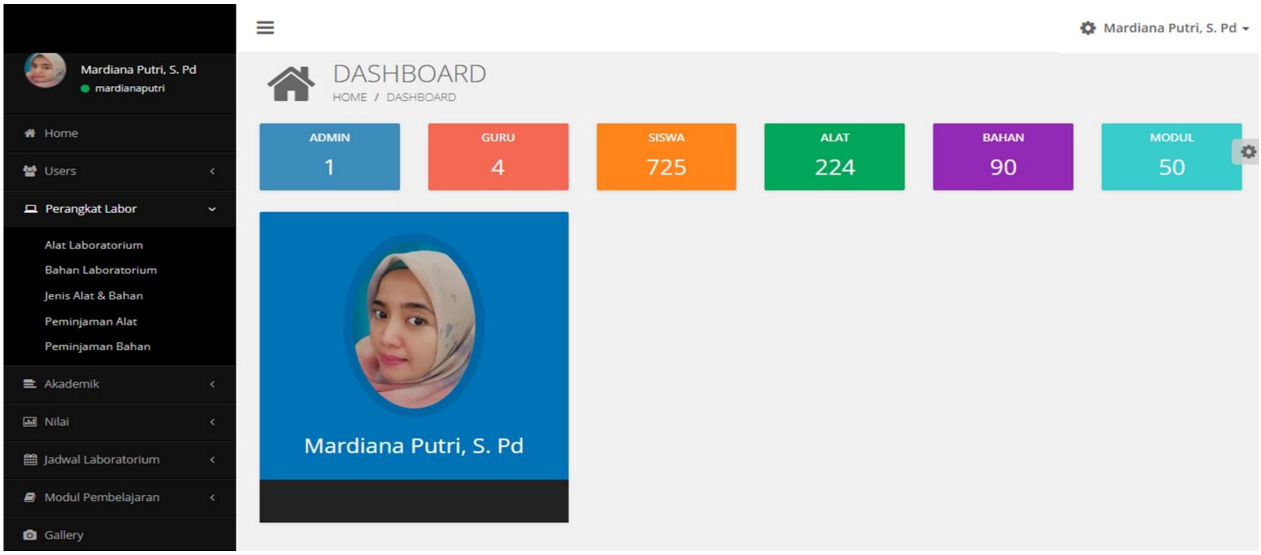
Appendices

The following appendices present screenshots of the interface, digital SOP schedule, and safety evaluation form to complement the reader's understanding of the SLIM KILAB implementation.

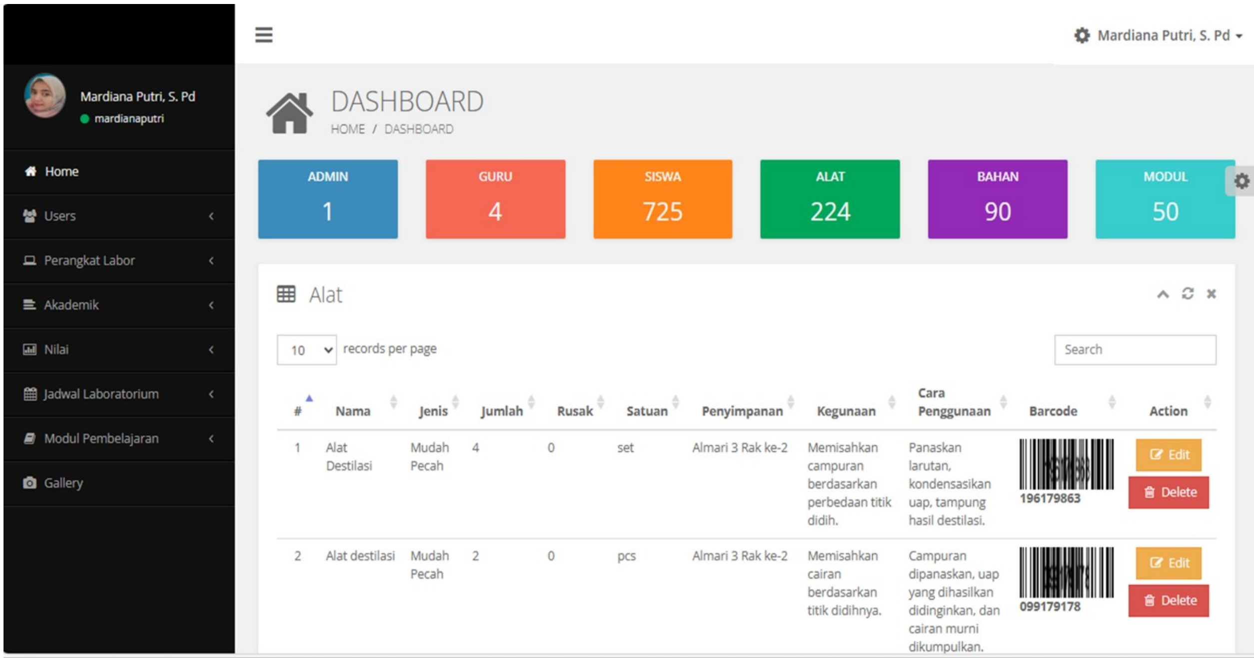


Appendix A Screenshot of SLIM KILAB Interface

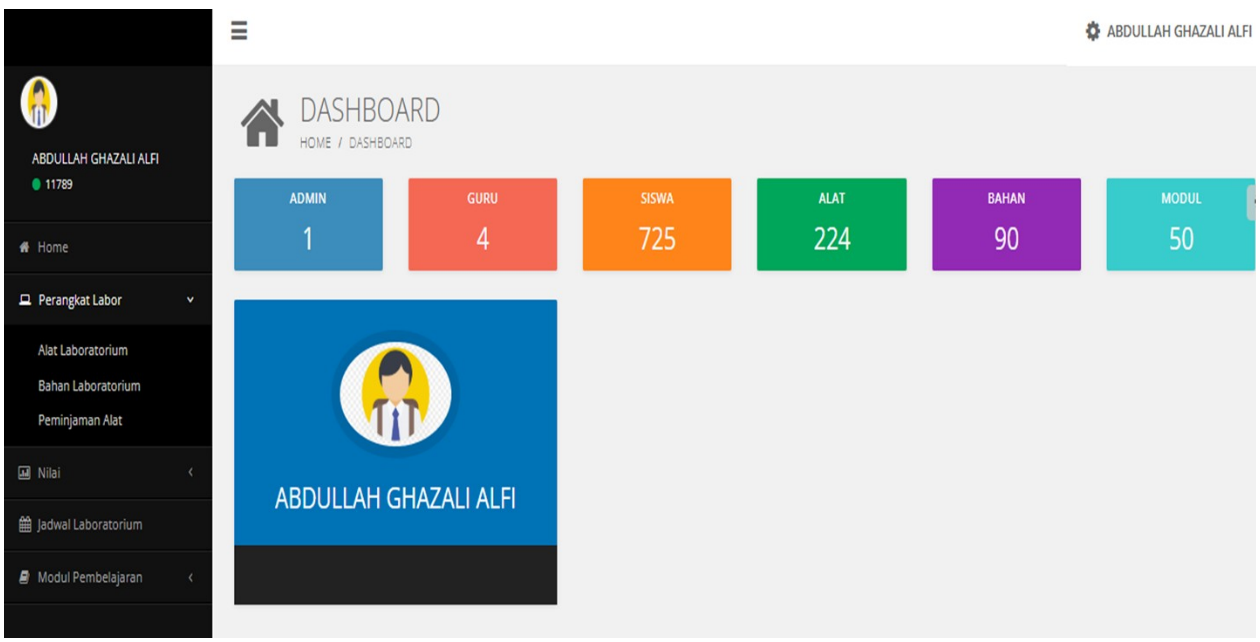
Admin user homepage



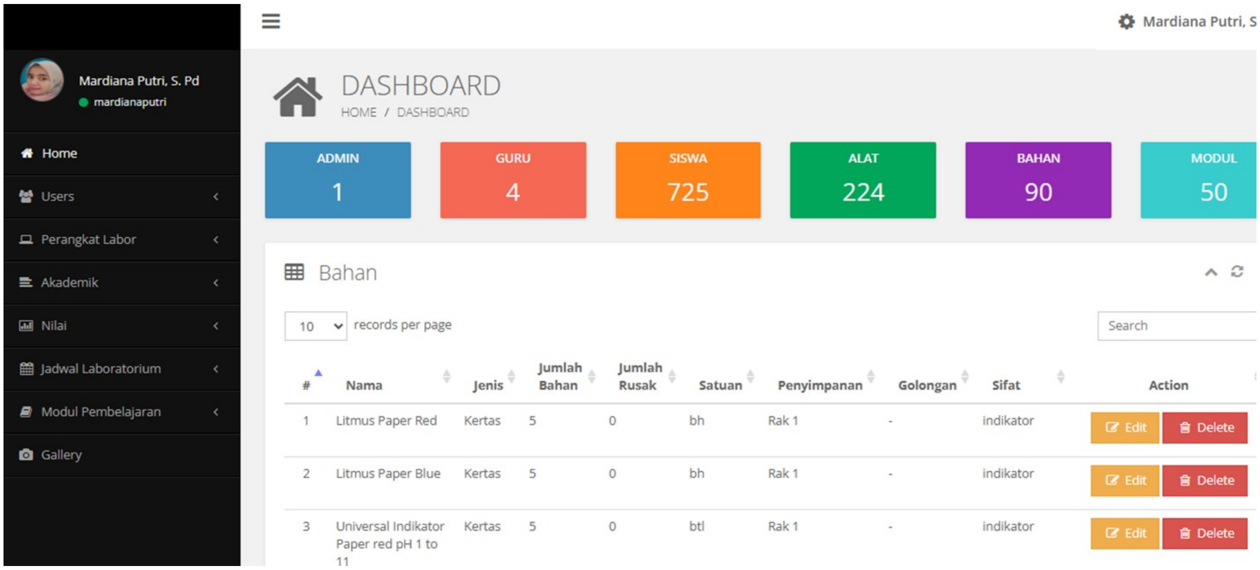
Teacher user homepage



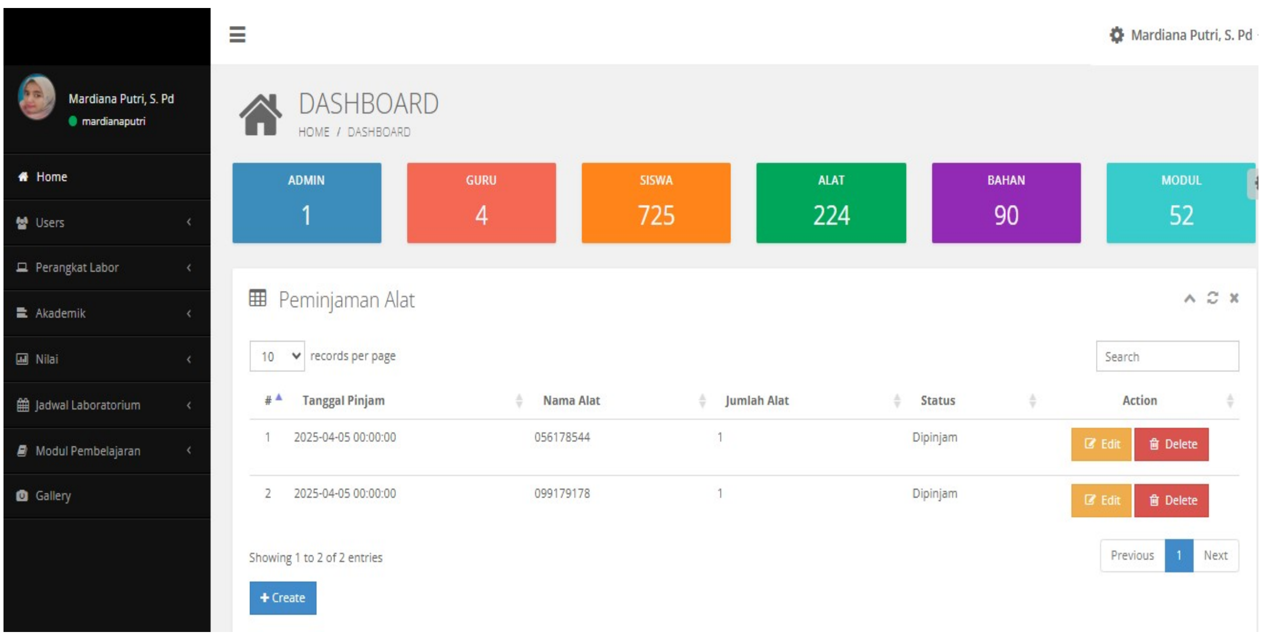
Student user homepage



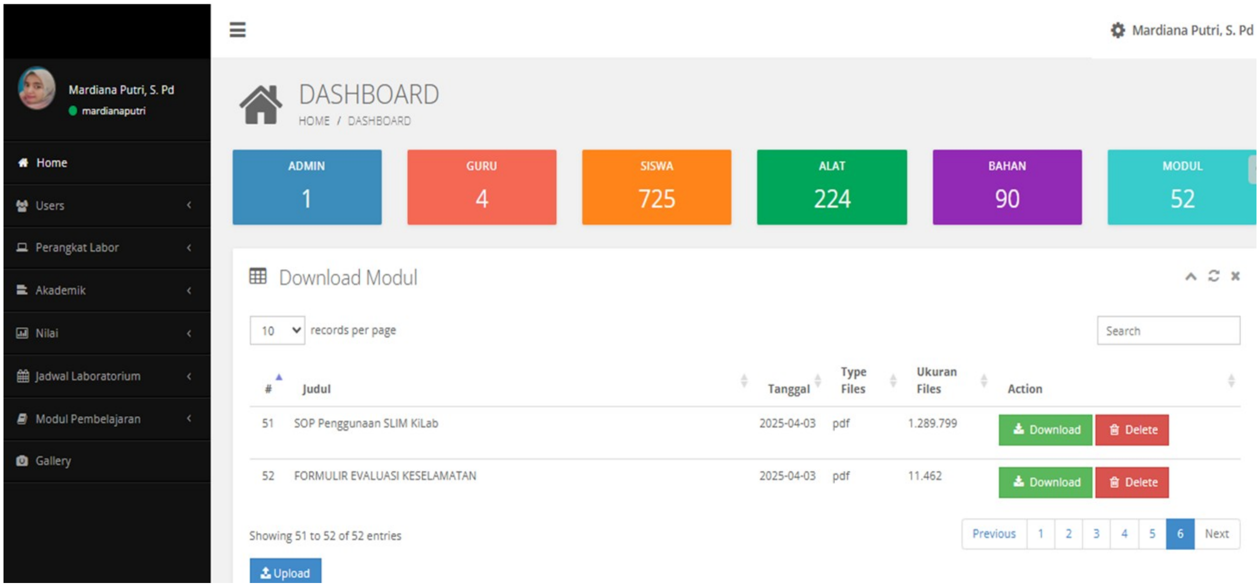
Equipment inventory



Material inventory



Equipment loan



Download module

Appendix B. Example of Digital Laboratory SOP Schedule

DIGITAL LABORATORY SOP SCHEDULE

No	Langkah Kegiatan Praktikum	Penanggung Jawab	Tanggal	Status
1	Cek ketersediaan alat	Laboran	01-04-2025	✓
2	Verifikasi bahan kimia	Guru	02-04-2025	✓
3	Penggunaan APD	Siswa	03-04-2025	✓
4	Praktikum dilaksanakan	Siswa & Guru	04-04-2025	✓
5	Pengembalian alat	Laboran	04-04-2025	✓

Appendix C. Laboratory Safety Evaluation Form

SAFETY EVALUATION FORM (SAFETY CHECKLIST)

No	Aspek yang Dievaluasi	Ada	Tidak	Catatan
1	Alat Pemadam Api tersedia dan berfungsi			
2	Jalur evakuasi jelas dan tidak terhalang			
3	Bahan kimia diberi label dan tersimpan aman			
4	Penggunaan APD oleh siswa terpantau			

5	Ruangan memiliki ventilasi yang baik			